16. **sejunctus** Harris and Drake, 1944: Brazil.
    Genus NOTOPLOCORIS Usinger, 1941
    Type, *Notoplocoris montei* Usinger
17. **mendesi** Wygodzinsky, 1948: Brazil.
18. **montei** Usinger, 1941: Brazil.
19. **potensis** Drake and Harris, 1944: Brazil.
20. **sobrali** Wygodzinsky, 1948: Brazil.
    Tribe MEZIRINI Usinger, 1941
    Genus PICTINUS Stål, 1873
    Type, *Pictinus cinctipes*, Stål
21. **brasiliensis** (Wygodzinsky), 1948: Brazil.
22. **dureti** (Kormilev), 1953: Argentina.
23. **intermediarius** (Kormilev), 1953: Brazil.
24. **montrouzieri** Kormilev, 1953: Brazil.
25. **plaumanni** Kormilev, 1953: Brazil.
26. **teresopolitanus** (Wygodzinsky), 1948: Brazil.
27. **usingeri** (Wygodzinsky), 1948: Brazil.

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ZOOLOGY.—*Remarkably preserved fossil sea-pens and their Recent counterparts*

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(Received May 23, 1955)

The material to be described below, including as it does specimens of Recent and Tertiary pennatulaceans showing close morphological similarity, is indeed remarkable. It is even more so in view of the fact that the sea-pens in question are soft-bodied creatures that do not lend themselves to fossilization. The Recent material, four lots containing in all seven specimens, was collected in the Gulf of Mexico by the vessels *Albatross*, *Grampus*, and *Pelican*, and by C. T. Reed. The interesting suite of fossils from the Tertiary of Trinidad, collected by Dr. H. G. Kugler of Pointe-à-Pierre, was submitted to me for study by Dr. W. P. Woodring of the U. S. Geological Survey. Photographs of some of the specimens had earlier been sent by Dr. Kugler to Dr. Fred B. Phleger, who suggested that they might represent molds of some pennatulacean. This suggestion, passed along to Dr. Woodring, resulted in my seeing the photographs and, eventually, the specimens themselves. Subsequently, Dr. Kugler visited the Basel (Switzerland) Museum and arranged for similar fossils housed in that institution to be sent to me for consideration with the material from Trinidad. The specimens from the Basel Museum were collected in the Kei Islands, from a stratum of undertermined age.

I am greatly indebted to Dr. Woodring for the opportunity of seeing the fossil material and for arranging its transmittal to me. Needless to say, this study could not have been made but for the kindness of Dr. Kugler, collector of the Trinidad specimens. Dr. G. Arthur Cooper, curator of the Division of Invertebrate Paleontology, U. S. National Museum, made the excellent photographs reproduced on Fig. 2, for which I express sincere thanks. In the preparation of the specimens for study I have been greatly assisted by M. L. Peterson, Jr., of Arlington, Va., who has done the necessary cutting.

Except for *Cancellophycus* from the Lias, Jurassic and Cretaceous, as reported by Lucas (1938, 1940), pennatulacean octocorals are known in the fossil state only by their calcareous axes. Several genera have been erected for these fossils, and at least one "species" has been assigned to the Recent genus *Pavonaria* (=*Balticina*). It is,

of course, difficult, if not impossible, to base specific determinations of sea-pens upon characters of the axial rod alone. Therefore, it is of no small interest to discover remains of pennatulaceans referable to a modern genus by virtue of the remarkable preservation of the external gross morphology of nearly entire colonies. This was accomplished by the infilling of molds in soft mud by a coarser material. It is necessary to assume that the specimens were dislodged from their living positions and strewn over a mud bottom in which they left impressions that became filled with sand. Artificial fossils of very similar appearance were made by taking rubber casts from plaster molds of Recent specimens; two of these are shown on Fig. 2, *d* and *e*, made from the specimens bearing catalogue numbers 49758 and 43023 described below.

Several of the fossils were sectioned but none show any indication of the calcareous axial rod, so it must be concluded either that the axial rods were swept away from the area after decomposition of the soft parts, that conditions during the infilling of the molds were sufficiently acid to have dissolved away the axes, or that the entire animals were somehow transported away from the molds.

Although even generic determinations of Pennatulacea depend upon spicular, calycinal and zooidal characters none of which are preserved in the fossils, enough can be seen of the colonial morphology of the casts here described to warrant assigning them to the genus *Virgularia*. In this genus, the auto-zooids are fused into leaf-like outgrowths arranged biserially along most of the stem (rhachis); these polyp-leaves do not quite meet along one side of the rhachis and thus leave open what is usually called the dorsal track. Along the opposite side of the rhachis the leaves may meet or even fuse, but a distinct suture line is usually detectable. Siphonozooids occur on or between the polyp-leaves and commonly also along the dorsal track. No calcareous spicules occur in the leaves, but small, corpuscle-like sclerites may sometimes be found in the rhachis and stalk. The lower part of the stem, known as the stalk (Stiel) is free of polyp-leaves and serves to anchor the colony in soft bottoms.

Differentiation of the species depends upon, among other things, the position of the siphonozooids, the number of autozooids per leaf, and the degree of fusion of the autozooids making up the leaves. These features, like all other details of the soft parts, are not preserved in the casts. There is no way to distinguish the fossil specimens from the Recent species now living in the Gulf of Mexico, so they must be assigned to the same species. This is not so radical a course as it may at first seem, inasmuch as two Recent pennatulaceans now live on both sides of the Panamanian isthmus. The Atlantic and Pacific populations of one species are looked upon as indistinguishable, and of the other as representing only forms, although they certainly have been separated since sometime in the Miocene. The species thus seem to be quite stable and presumably have undergone little change since the Tertiary.

The four lots of Recent *Virgularia* from the Gulf of Mexico have been compared with specimens of *V. mirabilis* from Kiel, and with the various descriptions of that species in the literature. They prove to be not the same. The West Indian material more closely resembles *Virgularia rumphii* and *V. abies*, both East Indian forms, but differs in detail from those species also. It is therefore necessary to establish for the specimens from the Gulf of Mexico a new species, which will include the fossil casts from Trinidad as well. This species may be known as:

Virgularia presbytes, n. sp.

Figs. 1; 2, a–e

Virgularia spec. Deichmann, 1936, p. 274.
Virgularia mirabilis Bayer, 1952, p. 189; 1954, p. 281. Not *Pennatula mirabilis* O.F. Müller, 1776.

Diagnosis.—Virgularias with thick, fleshy polyp-leaves composed of 13–30 autozooids united by the full length of their anthosteles, showing no distinct projecting calyces and without marginal tubercles; leaves in pairs fused more or less completely on the ventral side of the rhachis but well-separated on the dorsal side, leaving free a distinctly grooved dorsal track; siphonozooids in 2–7 irregular, crowded rows between the polyp-leaves, in the larger specimens extending out onto the dorsal track in an irregular longitudinal row or field on either side of the

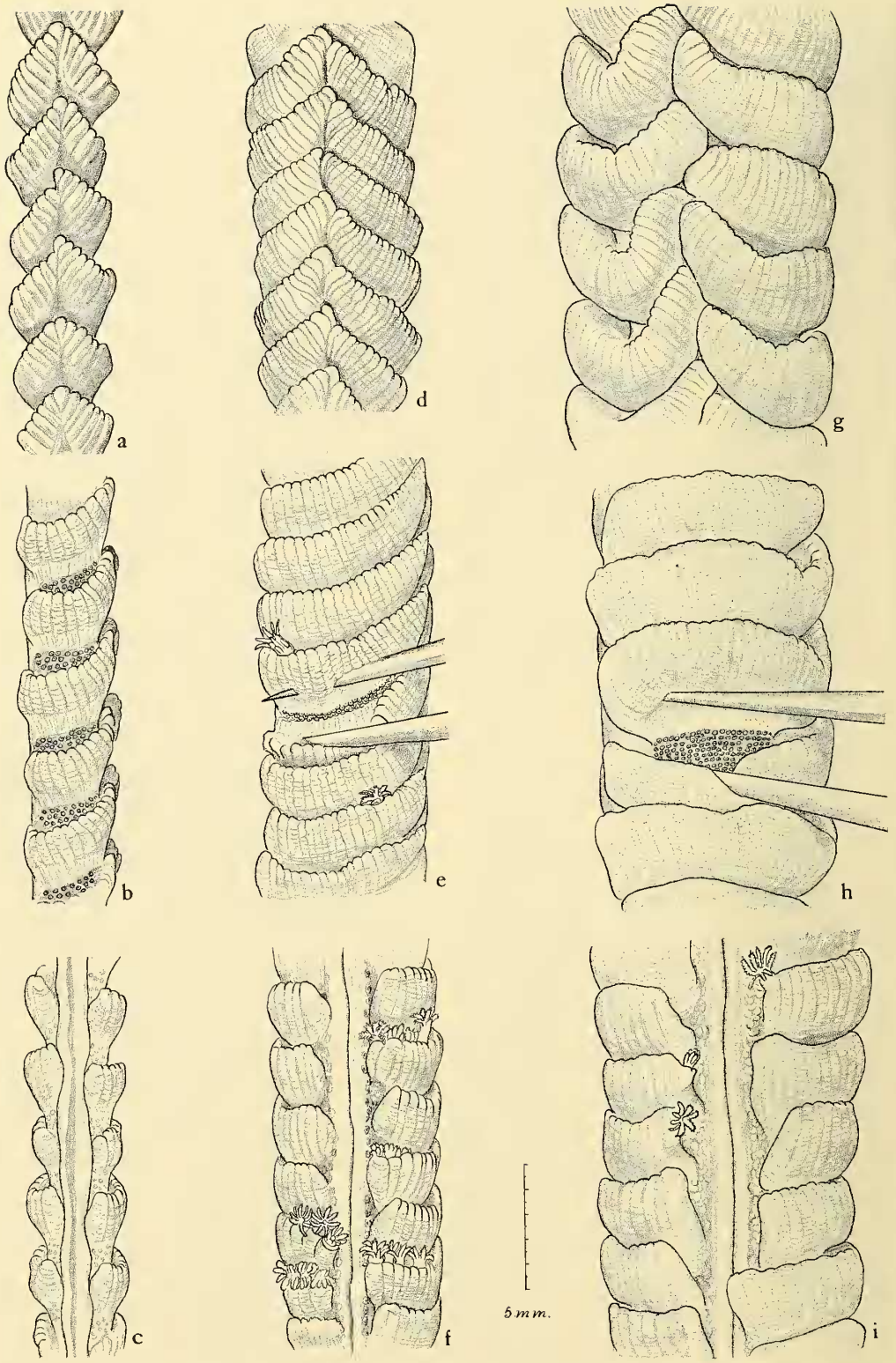

FIG. 1.—*Virgularia presbytes*, n.sp.: *a–c*, Specimen no. 49758, off Mobile, Ala. (*a*, ventral; *b*, lateral; *c*, dorsal views of rhachis); *d–f*, holotype, no. 50143, off Cape Canaveral, Fla. (*d*, ventral; *e*, lateral; *f*, dorsal views of rhachis); *g–i*, specimen no. 43023, off Galveston, Tex. (*g*, ventral; *h*, lateral; *i*, dorsal views of rhachis).

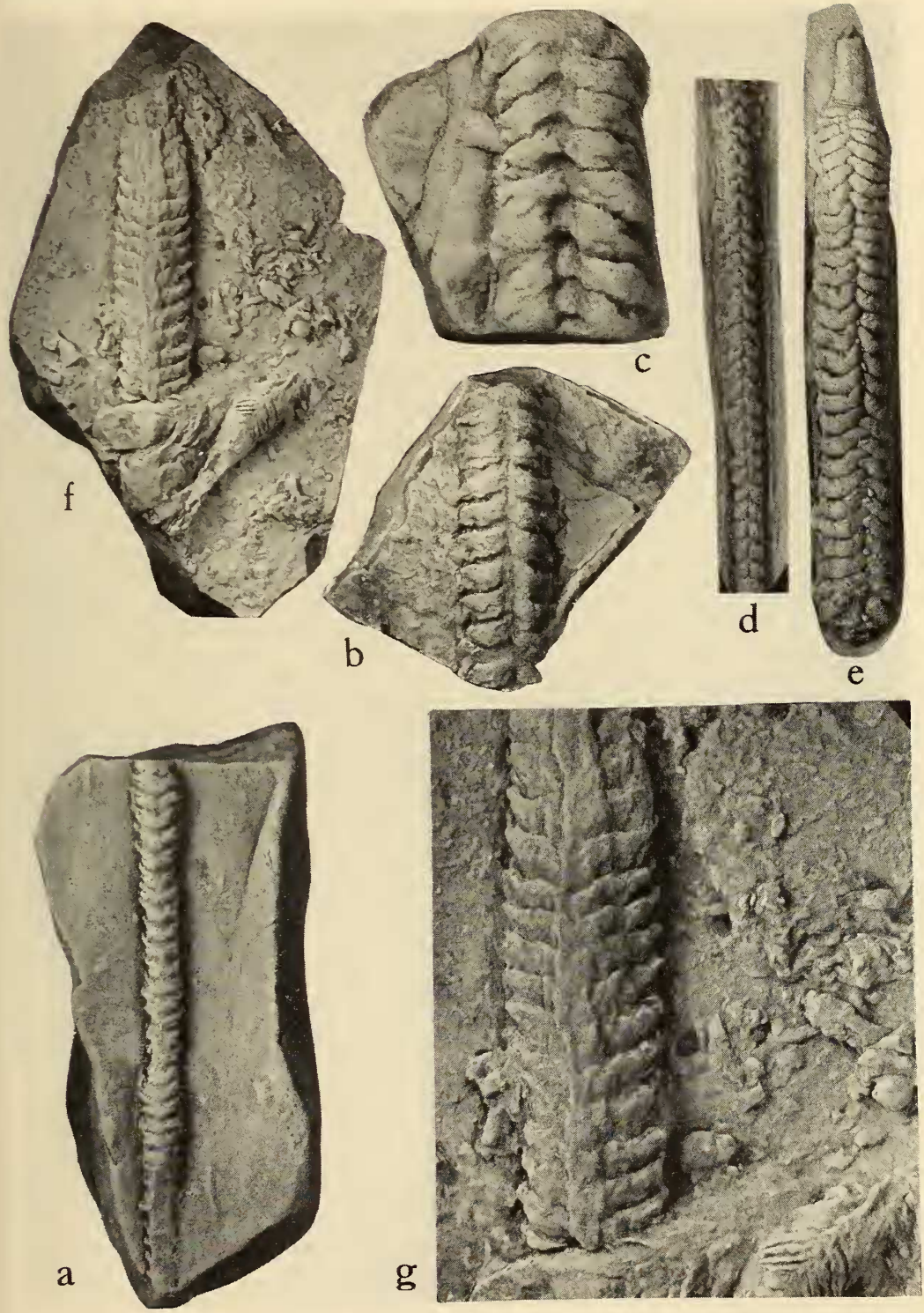

FIG. 2.—*a–e*, *Virgularia presbytes*, n.sp: *a–c*, Fossil specimens from the Pointe-à-Pierre formation of Trinidad; *d–e*, rubber casts of plaster molds made from the specimens shown in Fig. 1, *a* and *g*. *f–g*, *Pteroeides argenteum* (Ellis and Solander)?, fossil from Great Kei Island: *f*, Entire slab, reduced; *g*, part of same specimen, natural size (Basel Museum). All photographs by G. A. Cooper.

median groove. Axis stout, in cross section round toward the apex, oval or dorso-ventrally flattened toward the base. No spicules were found in either the polyp-leaves or the rhachis.

Descriptions.—The type lot, U.S.N.M. no. 49755, contains four specimens, one of which has been selected as the holotype and given the catalogue number 50143. Off Cape Canaveral, Fla., 28° 54′ N., 80° 39′ W.; 9 fathoms; *Pelican* station 171-5, January 19, 1940.

Specimen a: Length 164 mm; the axis is nearly round, 2.25 × 2.50 in diameter. At the upper end of the rhachis, where the polyp-leaves diminish in size, the axis is very stout and obviously once projected far beyond the tip of the fleshy rhachis. The diameter of the rhachis with its polyp-leaves is 5–7 mm. The leaves are thick, fleshy, directed upward, obliquely placed on the rhachis, their ventral ends higher; 14 pairs occur in 3 cm of rhachis length at about the middle of the specimen. There is a distinct dorsal track with a deep median groove; none of the pairs of leaves meet across it. The members of the pairs of polyp-leaves regularly meet and are fused along the ventral midline. The leaves are composed of the united anthosteles of 24–28 autozooids in single series. There are no free, projecting calyces, and the zooidal apertures are entire. Autozooids with well-developed gonads occur in the leaves throughout the length of the rhachis. The siphonozooids occur on the rhachis in three or four rows beneath each leaf, and extend out as an irregular row along the dorsal track on each side of the midline.

Specimen b: Length 159 mm.; the axial rod is incomplete at both top and bottom, and part of the rhachis and the stalk are missing below. At the distalmost part, the axis is round, 1.5 mm in diameter. The rhachis, including the polyp-leaves, is 5.0–6.5 mm in diameter. The leaves are thick and fleshy, situated as in specimen a; 12 or 13 pairs occur in 3 cm of length about the middle of the rhachis. The leaves do not overlap dorsally, and the dorsal track is distinct and grooved; ventrally the leaves of each pair meet and are fused together. The leaves are composed of 25–27 autozooids united by the full length of their anthosteles; no projecting calyces; no calycinal teeth. Well-developed gonads are observable in the autozooids of leaves at all levels except at the distal tip, where there are about six pairs of undeveloped leaves decreasing in size distad. The siphonozooids occupy all the rhachis surface between the leaves, closely packed in four or five indistinct rows; they extend out as an irregular row along each side of the dorsal track.

Specimen c: A specimen 151 mm in length is incomplete, like the other specimens of the lot, which it resembles closely. The rhachis, with leaves, is 5.0–6.5 mm in diameter; 13–15 leaves appear in 3 cm of length about the middle of the rhachis; the leaves contain usually 25 autozooids in a single series. Members of the leaf-pairs partially or completely fused ventrally. Siphonozooids between the leaves in three or four irregular rows, extending out onto the rhachis to form an irregular row along each side of the dorsal track. The autozooids in the fully developed leaves are fertile.

Holotype, U.S.N.M. no. 50143, selected from the foregoing lot, is a specimen 157 mm in length, with the axis incomplete both above and below, and the stalk and lower part of the rhachis missing. At its distal end the axis is round, 2 mm in diameter; at the proximal end it is slightly flattened, 2.25 × 2.5 mm in diameter. The rhachis with its polyp-leaves is 6–7 mm in diameter. The holotype closely resembles the other three members of the same lot as described above. There are 13 or 14 pairs of polyp-leaves in 3 cm of rhachis in the midregion; the leaves are made up of 24 or 25 autozooids completely fused in a single series, without any projecting, free calycular portion. The leaves of each pair are partially or completely fused along the ventral midline (Fig. 1, d); the dorsal track is distinct and shows the usual median groove (Fig. 1, f); the siphonozooids occur in 2–4 indistinct, crowded rows between the leaves (Fig. 1, e), and in an irregular row along each side of the dorsal track (Fig. 1, f). The autozooids of the fully developed leaves are fertile.

The salient characters of the holotype and of the paratypes from the same and other localities may be summarized in tabular form:

Specimen Cat No.	Diameter of rhachis	Diameter of axis	Number of autozooids per leaf	Number of leaves in 3 cm.	No. of rows of siphonozooids between leaves	No. of rows of siphonozooids on dorsal track
49758	3.5–4.5	1.5–2.25	13–15	10–15	3–4	0
43214	5–6	1.5–2	24–25	13–21	2–4	0
49755(a)	5–7	2.25–2.5	24–28	14	3–4	1
(b)	5–6.5	1.5	25–27	12–13	4–5	1
(c)	6–7	2–2.25	24–25	13–14	2–4	1
50143	5–6.5	2–2.25	25	13–15	3–4	1
43023	10	3–4	30	9–10	6–7	2–3

Localities.—Holotype and three paratypes (U.S.N.M. no. 50143; 49755) from *Pelican* station 171-5; off Cape Canaveral, Fla., 28° 54′ N., 80° 39′ W., 9 fathoms; January 19, 1940.

Paratypes as follows:

U.S.N.M. no 43023. *Grampus* station 10470; off Galveston, Tex., 29° 03′ N., 94° 26′ W., 9 fathoms; February 28, 1917.

U.S.N.M. no 43214. Near Corpus Christi, Tex. C.T.Reed.

U.S.N.M. no. 49758. *Albatross* station 2387; off Mobile, Ala., 29° 24′ N., 88° 04′ W., 32 fathoms; March 4, 1885.

Remarks.—Although there is some diversity, especially in size and stoutness, among the specimens examined, it is impossible to separate them on any scientific grounds into species conforming with the three size groups represented.

All the specimens agree in: (1) the thick, strongly adherent, closely placed polyp-leaves made up of completely fused autozooids; (2) the absence of any free calycular part of autozooids; (3) the absence of any teeth or tubercles around the autozooid apertures; (4) the multiple rows of siphonozooids between the polyp-leaves; and (5) the very stout, rigid axial rods.

There is variation, often between specimens of very similar appearance, in (1) the number of rows of siphonozooids between the leaves; (2) the number of siphonozooids extending out onto the dorsal track; and (3) the relative stoutness of the axis.

It seems preferable to retain all of the specimens under a single species, at least until enough material becomes available to permit a re-evaluation of characters.

The specimen from Corpus Christi was briefly mentioned by Miss Deichmann (1936, p. 274), who noted a similarity with *Virgularia schultzei*. That species, however, has its siphonozooids on the polyp-leaves, unlike the present material.

In some respects, *Virgularia presbytes* resembles *V. abies* (Kölliker) from Japan. The latter has a larger number of autozooids (40) in the leaves, which have sinuous margins, a single row of siphonozooids between the leaves, and a double row on either side of the dorsal track. The species must therefore be considered distinct.

Fossil specimens.—The specimens are all three dimensional sandstone casts of molds in silt or silty shale. They have previously been determined as the tracks of mollusks and called "bilobites" or "Palaeobullias." The manner in which individuals may lie one upon another precludes their being the trails of any organism, and their great similarity in form to certain sea-pens suggests that in reality they are casts of those animals. The fact that a Recent pennatulid now living in the Gulf of Mexico can be distinguished by no known scientific means from the casts from Trinidad lends further support to this view.

Although the three dimensional preservation of a soft-bodied organism may seem remarkable, it is surely no more so than the preservation of a molluscan trail in the mud. Pennatulaceans live on muddy substrates in which they are anchored by the fleshy, often bulblike, lower end of the stalk. The colony stands erect, with the polypiferous portion projecting from the mud. It must be assumed that the living specimens were torn from their normal positions and strewn about over a muddy surface in which they left their impressions. Such impressions would have been very fugitive and to be preserved must have been in very quiet waters or exposed to air until filled in and covered over by the material that is now sandstone.

The general nature of the formation in which these fossils occur is pertinent to the problem of preservation, and Mr. Kugler's description of it reads as follows:

> At its type locality the Pointe-a-Pierre formation consists of about 120 feet of fine-bedded dark grey silt and silty shale with regular intercalations of cubical fracturing quartzitic sandstones and massive coarse grit up to 10 feet thick. The sandstones show graded bedding and some of the conglomeratic layers are the result of turbidity currents. Flowcasts, the infills of fine-grained sandstone in grooved silt surfaces, are frequent and so are flowage structures inside some very fine grained quartzitic sandstones. An arenaceous assemblage of foraminifera indicate muddy bottom environment during part of the Claiborn and/or Wilcox time when the Pointe-a-Pierre formation was deposited in a thickness of up to 700 feet, forming some topographically prominent features in the Central Range of Trinidad and Eastern Venezuela.
>
> The only megafossil remains found in the Pointe-a-Pierre formation are occasional "tracks" termed "Bilobites" or "Palaeobullias" in private reports. These and also some "Helminthoides" are indicative of "Flysch"-like rocks as known from the Carpathians and Alps where they represent foredeep deposits associated with advancing thrust sheets. The nature of such rocks is characterized in Trinidad by coarser grains, often silt pebbles, at the bottom of a sand layer. Upwards the coarse material is graded into a finer sandstone and finally into almost varved silt with films of fine comminuted carbonaceous matter separating the silt laminae of 1 to 2 mm. thickness.

None of the "tracks" collected was actually found in situ, but mostly amongst the block debris at the base of the cliff at Pointe-a-Pierre or along the coast where the sandstone blocks are exposed to the action of waves. However, amongst the flow casts on the bottom side of some flaggy sandstones other "tracks" were found in situ, and the same tracks were also noticed together with "Bilobites," thus rendering a co-existence most likely. All the protruding casts of tracks on the flaggy sandstone surfaces must be infills of hollows formed in the top layer of the silt below. Fig. 305, p. 368, of O. Abel's "Vorzeitliche Lebensspuren" (1935) represents conditions almost identical to those at Pointe-a-Pierre. In fact specimen K.9628 from the San Fabian Quarry in the Marie Douleur Valley east of Pointe-a-Pierre, is almost a direct proof of this assertion. When this specimen was found at the face of the quarry, it was still covered with a light grey, silty clay which in fragments is still found sticking between the "ribs" of the "Bilobites." The sand must have filled a mold in the silt and this observation was made on all the samples collected, with the exception of one where the mold of a "Bilobites" was found in a fine-grained quartzitic sandstone. This mold must have been filled with silt or a coarser sandstone that subsequently weathered and left the original mold. The grain size and material of the "Bilobites" casts are the same as that of the adjoining part of the flaggy sandstone, hence there could not be a replacement of the tissue of the original animal or plant by mineral matter. This point is stressed on account of the suggestion that "Bilobites" may actually have been a *Virgularia*-like fossil.

The specimens themselves show a wider variation in size than do the Recent individuals thus far examined. They range in width of rhachis from about 3 mm to over 25 mm. The casts are hemicylindrical, usually straight or nearly so; on either side of a median longitudinal groove or suture, which represents the dorsal track or the ventral midline of Recent colonies, there are oblique transverse grooves which cut the half-cylinder into lappets representing the polyp-leaves. On some specimens the median track is wide, distinct, and grooved, and from the orientation of the leaves obviously represents the dorsal track; on others it is narrow or remains only as a junction line of the leaves of opposite sides and thus represents the ventral midline. The smaller specimens (under 15 mm in diameter) have 8–16 pairs of leaves in 3 cm of length, while the larger ones (17–30 mm in diameter) have only 5 or 6 pairs in the same length.

Fig. 2 a–e shows the range of sizes among the fossil individuals, and compares them with casts of Recent specimens, Fig. 2 d–e. All are natural size.

Virgularia sp.

In the collection of the Basel Museum is a large sandstone slab measuring about 26 x 22 cm, from Great Kei Island, which is crossed by a cast of what appears to be a large *Virgularia*. The width of the cast itself is about 20 mm; there are approximately 35 pairs of obliquely placed lappets roughly 1 cm apart; they converge proximad, indicating that it is the dorsal aspect of the colony that is exposed. Although the general configuration of the cast indicates a *Virgularia*, it is not at present possible to assign it to any of the known species.

Horizon.—Eocene or Oligocene?

Locality.— Near the village of Ohowait, east coast of the middle part of Great Kei Island, south eastern Moluccas. F. Weber, 1926. Basel Museum.

Pteroeides argenteum (Ellis and Solander, 1786)? Fig. 2, f–g

A smaller slab from Great Kei shows a cast probably represents a different pennatulid. From the jagged edges of the lappets, one concludes that the species was one with a stong armature of spicules in the polyp-leaves. In size and apparent proportions it agrees reasonably well with Ellis and Solander's *Pennatula argentea*, a Recent species of she East Indies, that has such armature.

The photographs, Fig. 2, f and g, show the entire slab, reduced, and a detail, natural size. It can be seen from Fig. 2, f, by the way several individuals lie on top of one another, that these are the casts of solid objects and not of trails in the mud.

Horizon and locality.— Same as for the foregoing. Basel Museum.

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